



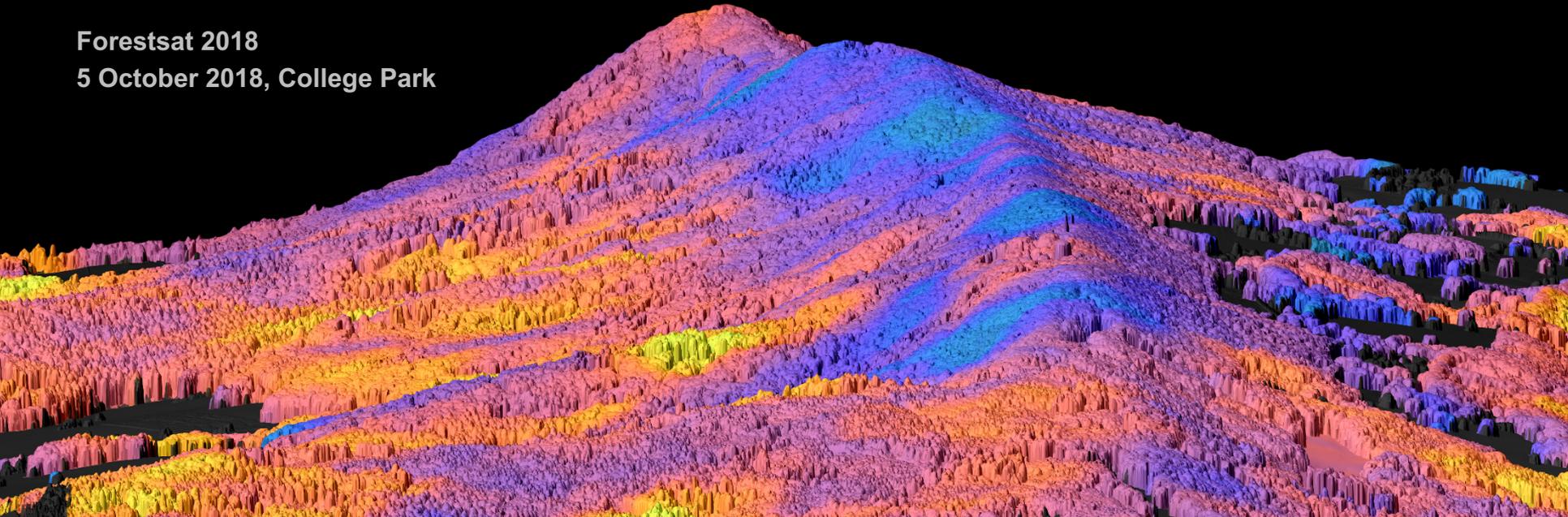
Jet Propulsion Laboratory
California Institute of Technology

Mapping functional diversity of forests with remote sensing

FD Schneider , F Morsdorf, B Schmid, OL Petchey, A Hueni, P Moorcroft, DS Schimel & ME Schaepman

Forestsat 2018

5 October 2018, College Park



Biodiversity-Productivity Relationship

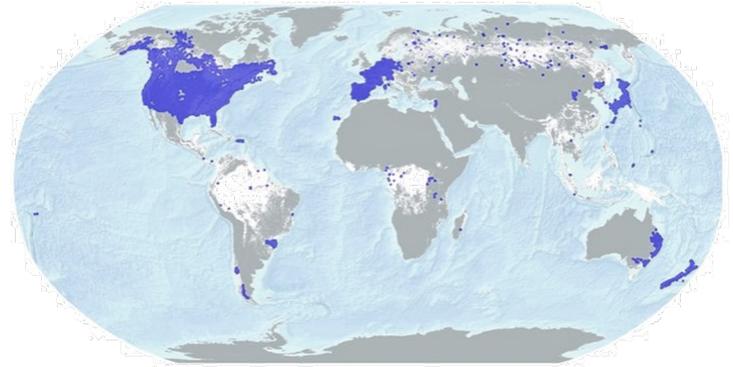
Plant diversity as indicator for ecosystem health, stability and functioning

RESEARCH ARTICLE

FOREST ECOLOGY

Positive biodiversity-productivity relationship predominant in global forests

Jingjing Liang,^{1*} Thomas W. Crowther,^{2,3†} Nicolas Picard,⁴ Susan Wiser,⁵ Mo Zhou,¹ Giorgio Alberti,⁶ Ernst-Detlef Schulze,⁷ A. David McGuire,⁸ Fabio Bozzato,⁹



LETTER

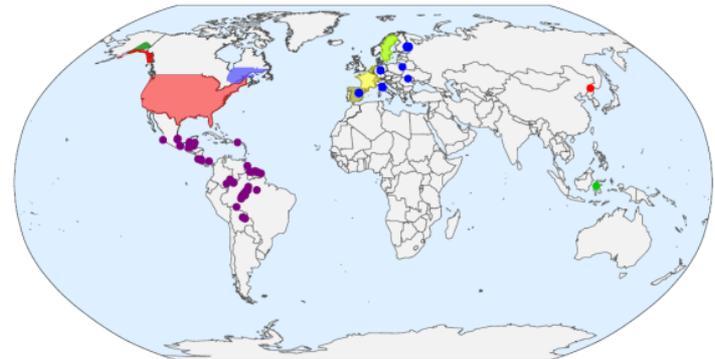
doi:10.1038/nature23886

Biodiversity effects in the wild are common and as strong as key drivers of productivity

J. Emmett Duffy,¹ Casey M. Godwin² & Bradley J. Cardinale²

b

Forests



How do we measure Biodiversity?

Remote Sensing of Plant Functional Traits



The biodiversity revolution

Ecologists are increasingly looking at traits — rather than species — to measure the health of ecosystems.

BY RACHEL CORNABERY



“Just going for species numbers doesn’t allow us to harness all this incredibly rich information of how the real world operates.”

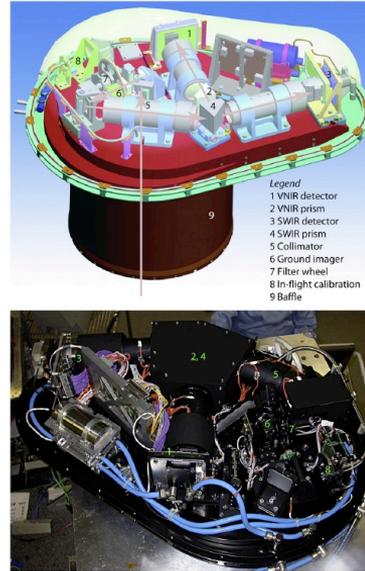
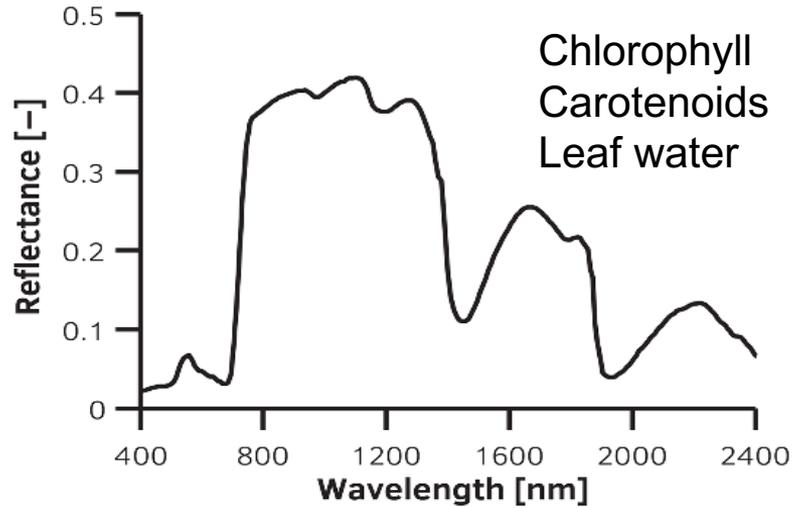
Method – Airborne Laser Scanning

Canopy Height
Canopy Density
Canopy Layering



Method – Imaging Spectroscopy

Airborne imaging spectrometer APEX



Photos: Andy Hueni

Schaepman, et al. (2015) RSE; Schneider, et al. (2014)



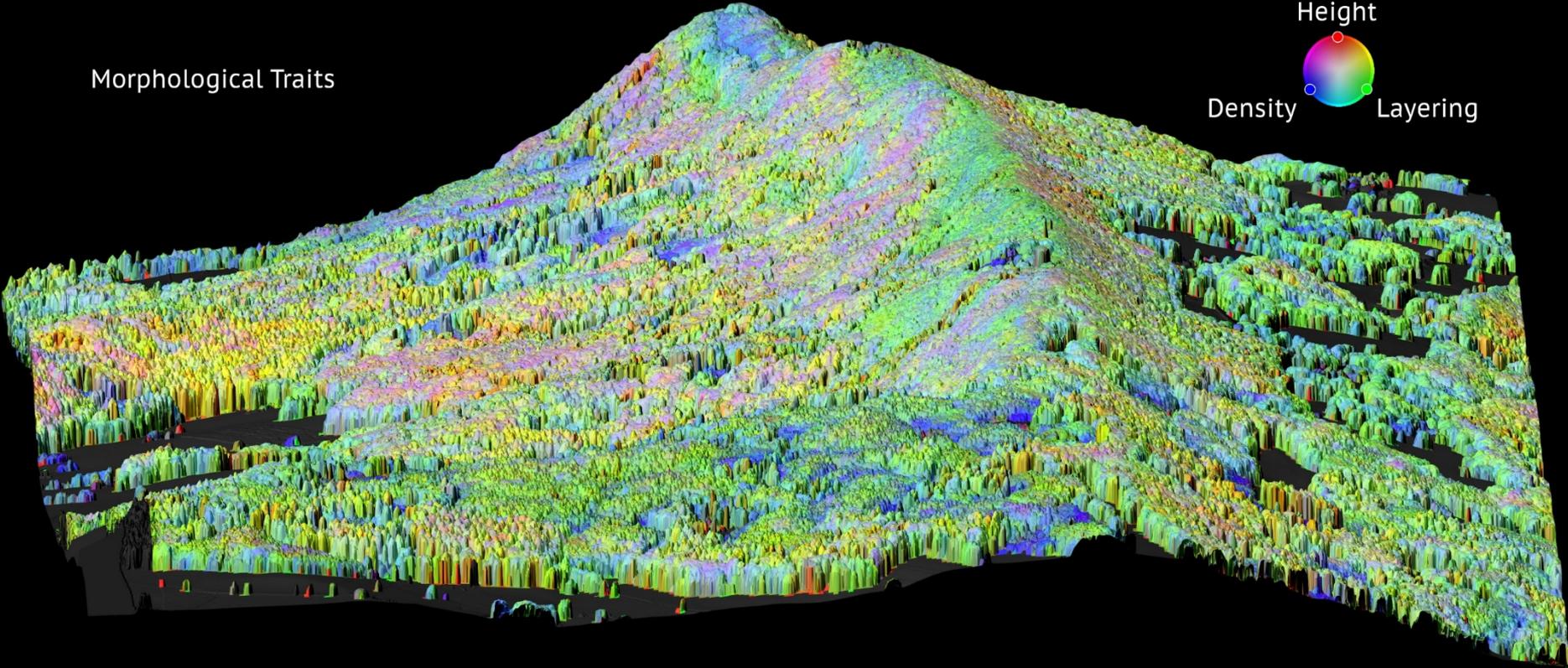
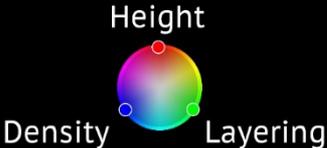
Test Case in Switzerland

Small-Scale Airborne Data at Individual Tree Level



Canopy Morphological Traits

Morphological Traits



Leaf Physiological Traits

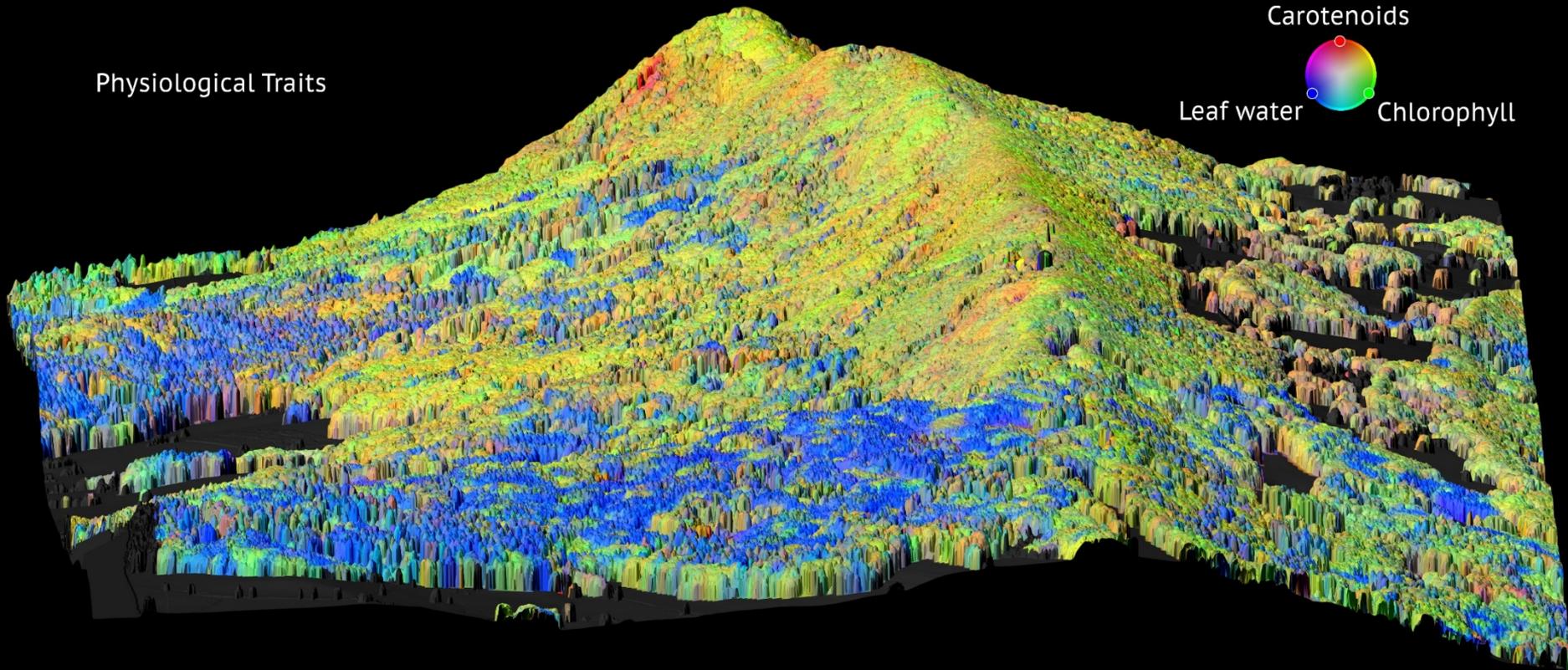
Physiological Traits

Carotenoids



Leaf water

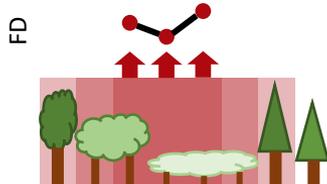
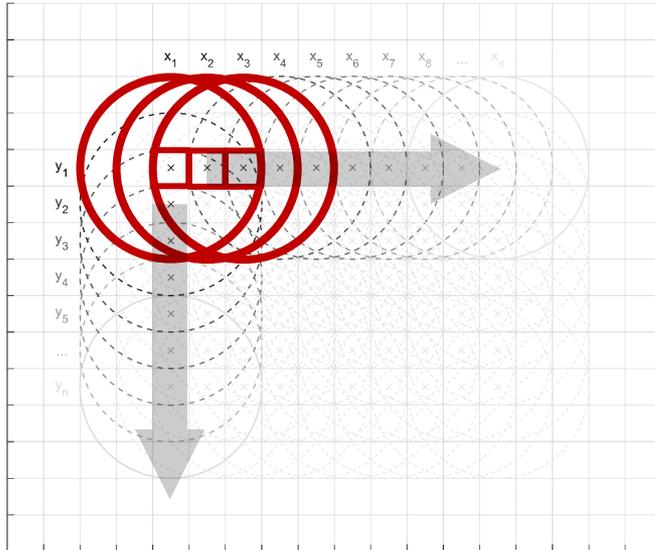
Chlorophyll



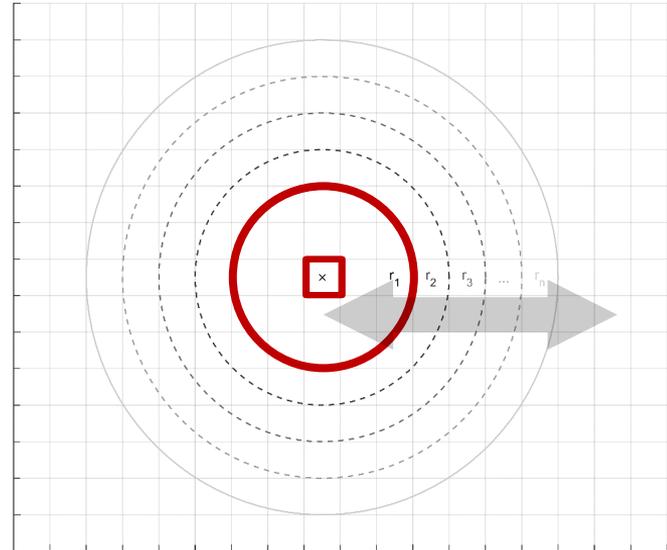
Continuous Diversity Mapping

From Traits to Diversity

Moving-Window

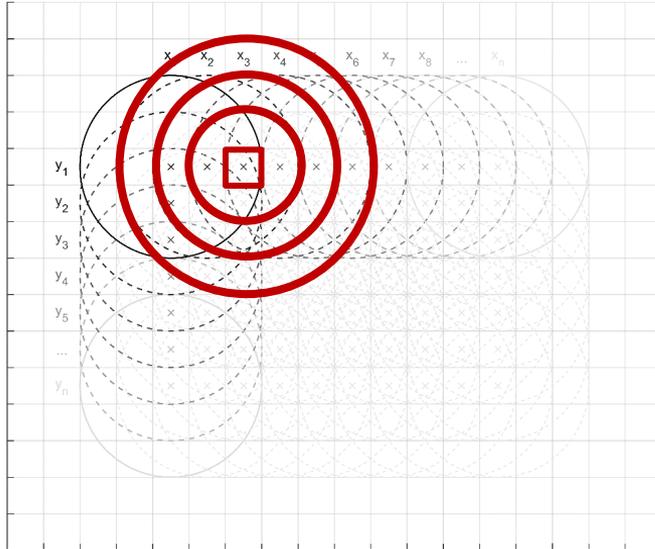


Radius

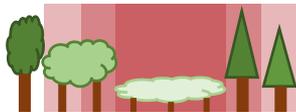
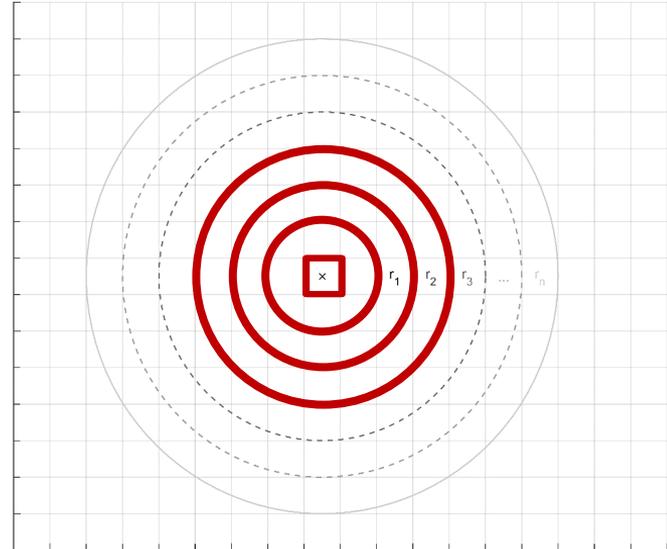


Continuous Diversity Mapping

From Traits to Diversity

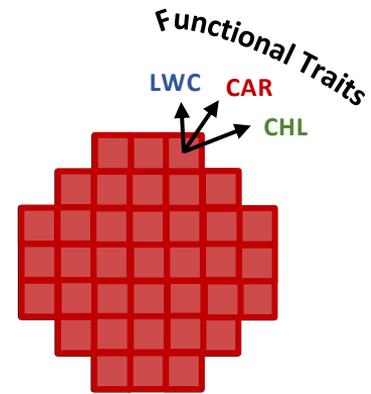
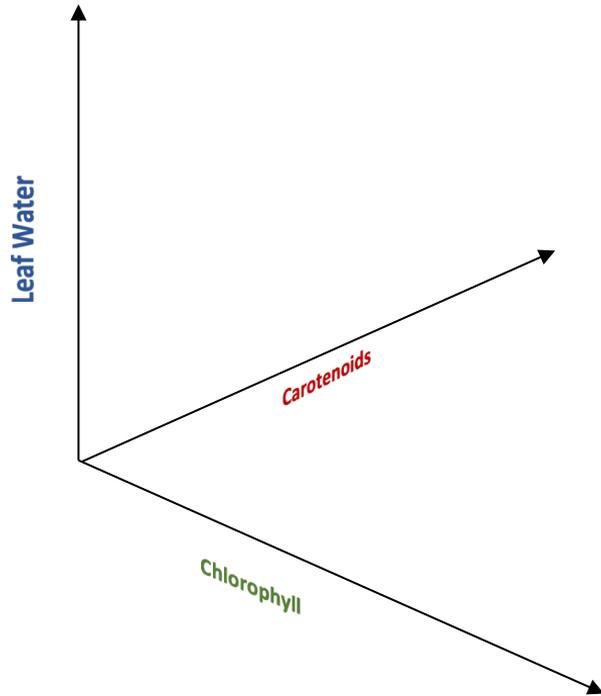


Radius



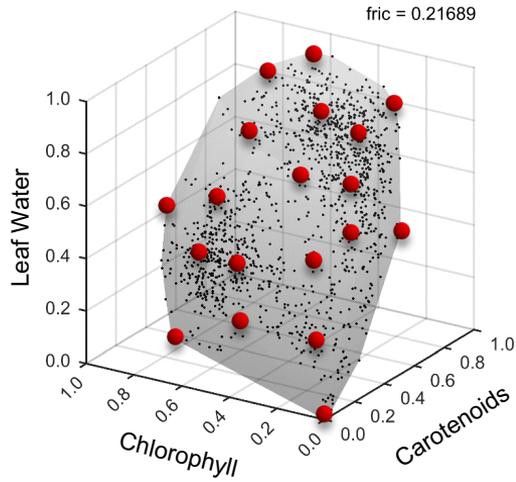
Functional Diversity Measures

Analyzing the Trait Space

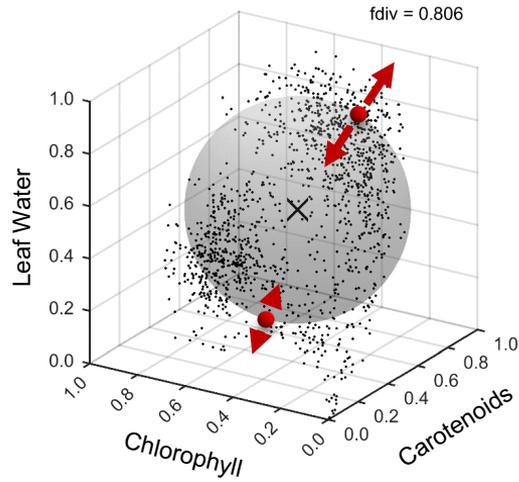


Functional Diversity Measures

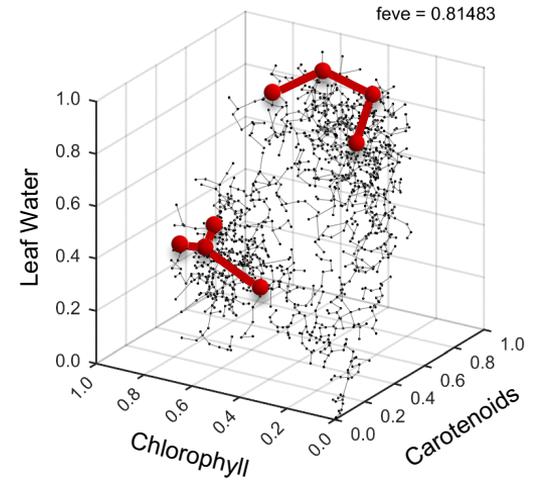
Analyzing the Trait Space



Functional Richness



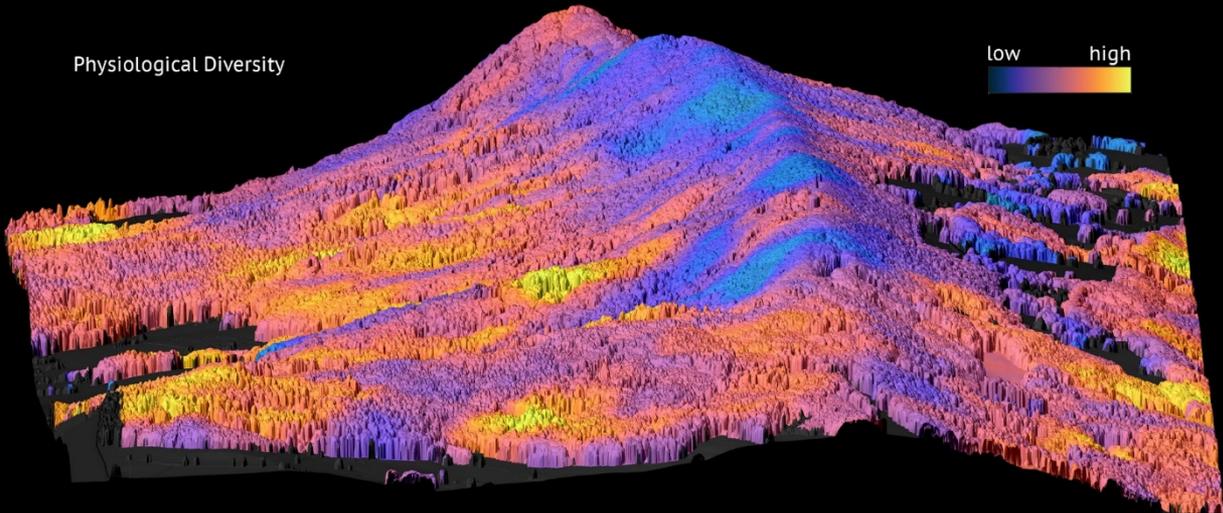
Functional Divergence



Functional Evenness



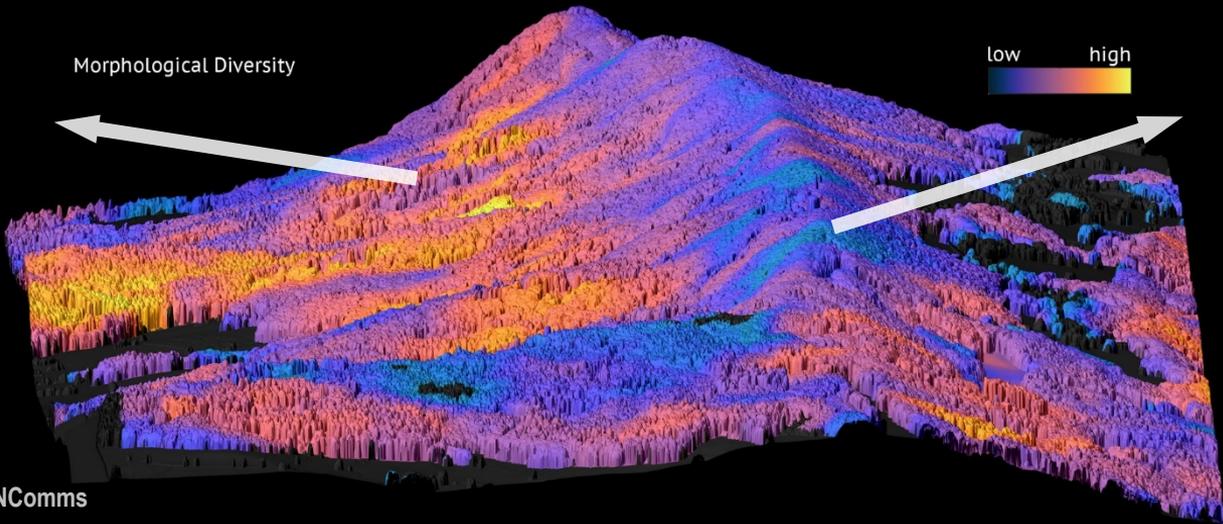
Physiological Diversity



low high



Morphological Diversity



low high

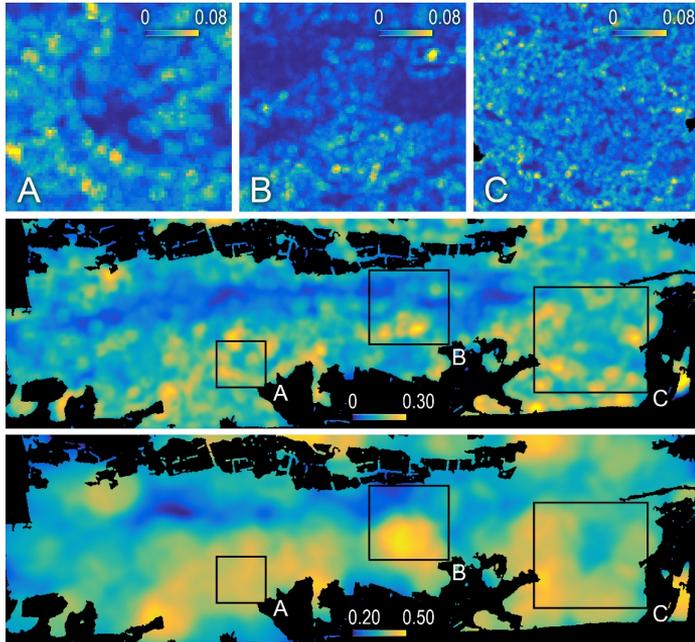


Photos: edaskliokys.ch, rainolo.ch

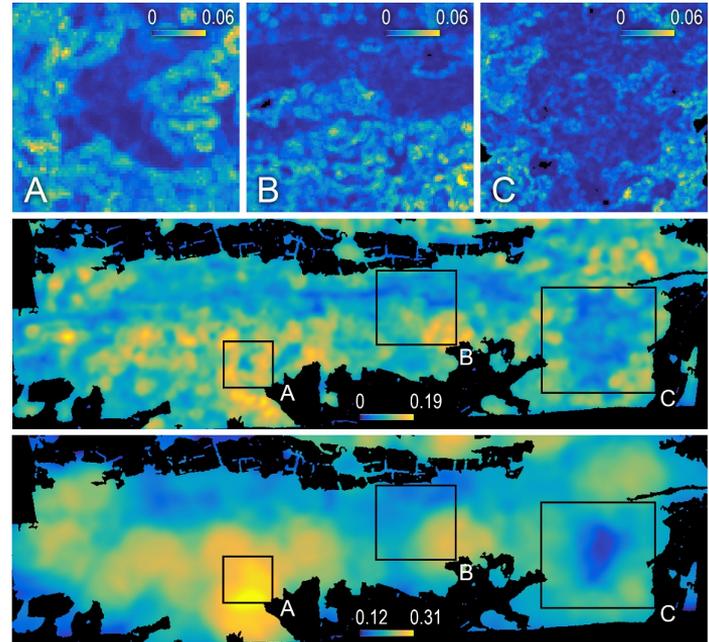
Scale Dependence of Diversity

Diversity-Area Relationship

Physiological Richness



Morphological Richness



Radius

12 m

60 m

240 m

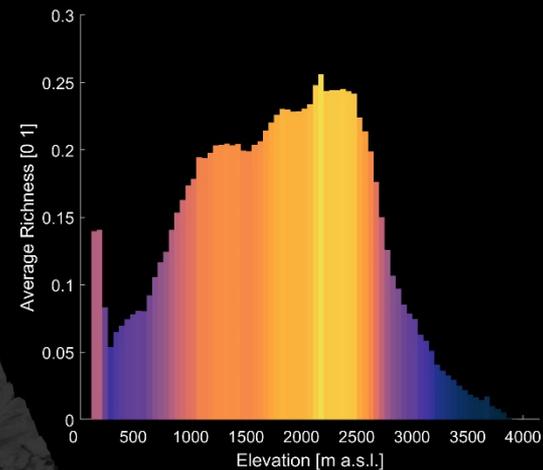
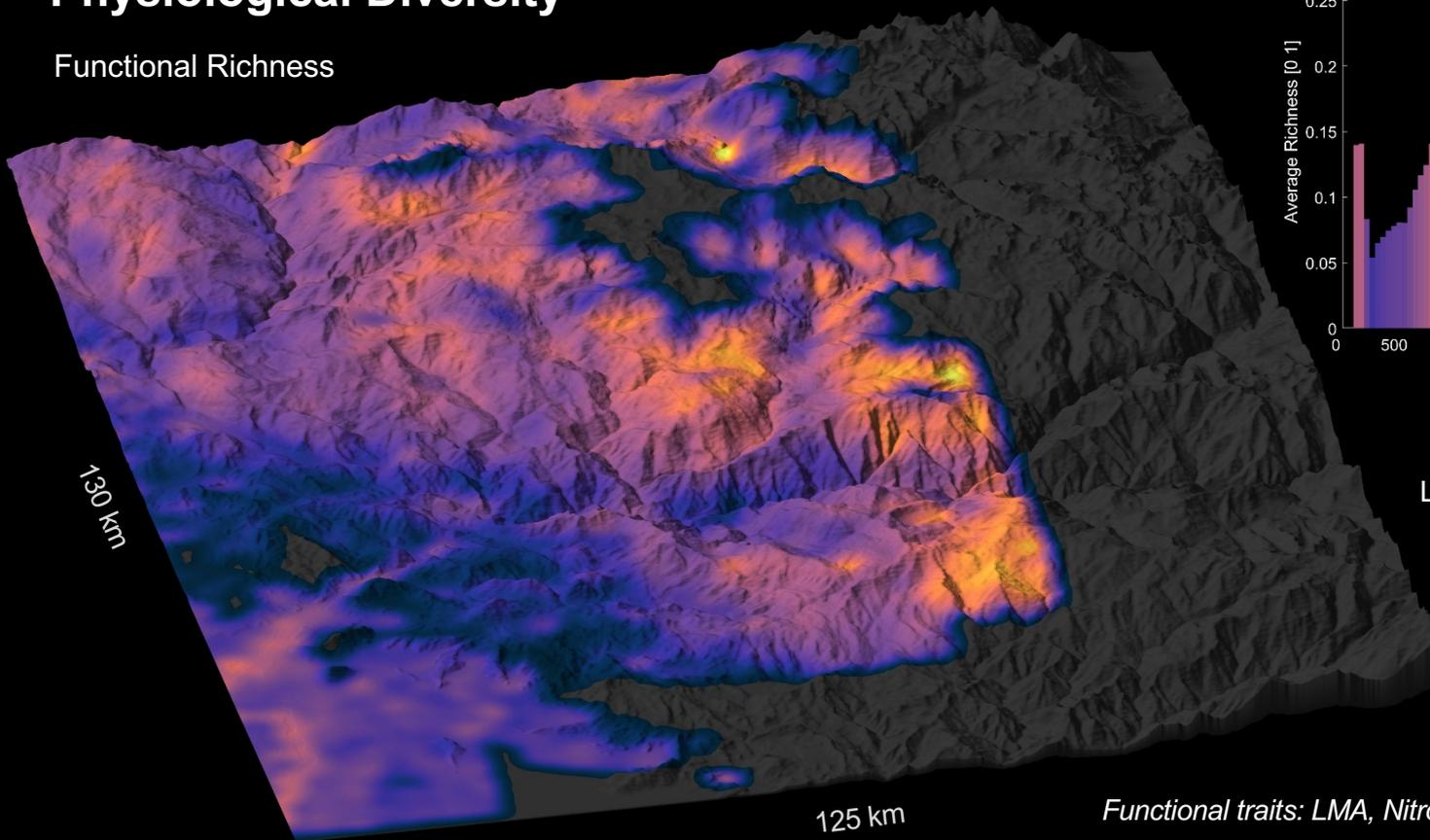
Test Case in California

Large-Scale Airborne Data at Community Level



Physiological Diversity

Functional Richness

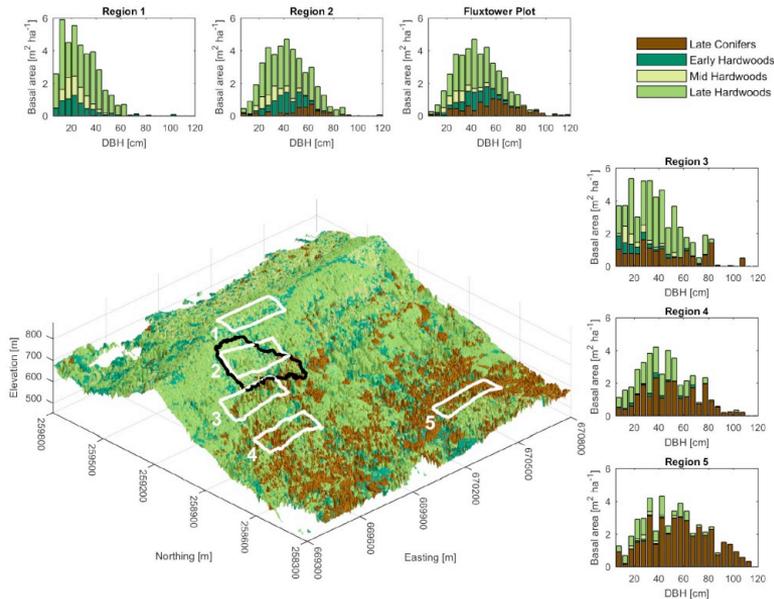


Leaf Physiology
1 km Radius

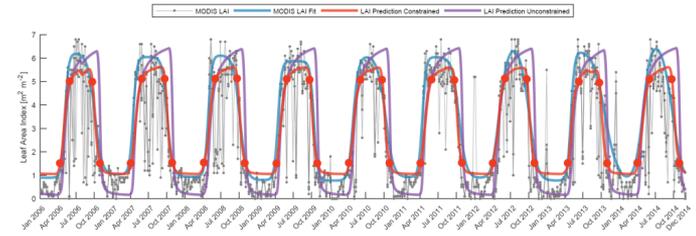
From Diversity to Functioning

Informing an Ecosystem Model with Remote Sensing Data

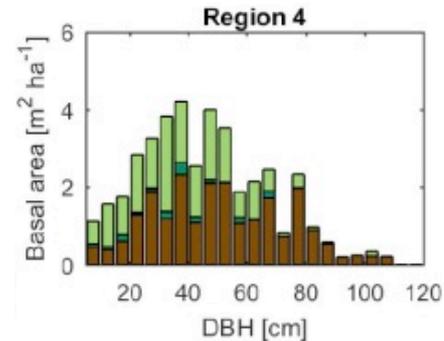
- Composition, Structure, Phenology



Phenology



Structure
Composition



Predicting Carbon Uptake

RS Data to Improve Model Predictions in ED2

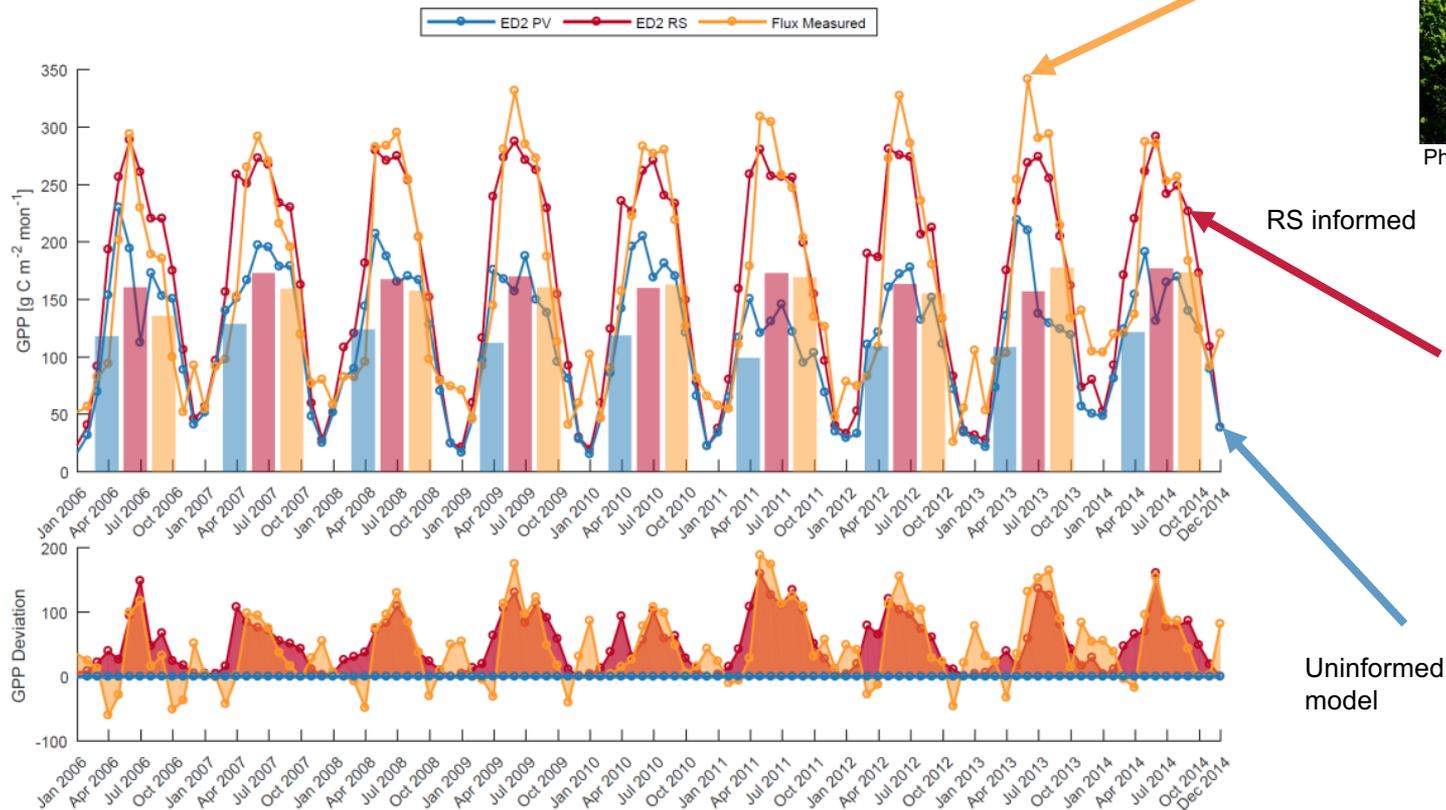
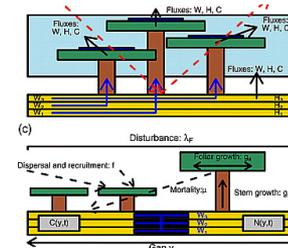
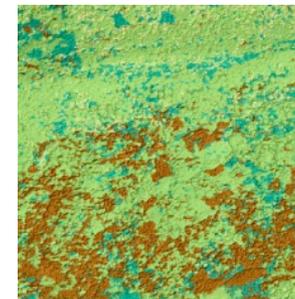


Photo: Reik Leiterer



Schneider, et al. in preparation; Moorcroft, et al. (2001) EM

Conclusion

- Diversity mapping based on plant functional traits
 - Which traits are most relevant and how much of total diversity can be explained?
- Community-scale measurements from space
 - Airborne campaigns for scaling between in-situ and spaceborne measurements
- Link diversity patterns to ecosystem stability and productivity
 - Global biodiversity observatory
- Integration with ecosystem models
 - Wall-to-wall functional traits and trait diversity can help to improve modeling and predicting energy, water and carbon fluxes



Thank you

Ryan Pavlick, Phil Townsend,
David Thompson, Reinhard Furrer



URPP
Global Change
and Biodiversity



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